DIELECTRIC AND HYDRAULIC RESPONSE OF SELECTED FOREST CANOPIES AT THE BOREAS TEST SITES IN CANADA

Kyle C. McDonald [1], Reiner Zimmermann [1], Ram Oren [2] and JoBea Way [1]
[1] Jet Propulsion Laboratory, California Institute of Technology
4800 Oak Grove Drive, Pasadena, CA 91109, U.S.A.
Phone: +1-81 8-354-3263, FAX: +1-818-354-9476
email: kyle.mcdonald@jpl.nasa.gov
[2] Duke University, School of the Environment
Durham, NC 27706, U.S.A

INTRODUCTION

The Boreal Ecosystem - Atmosphere Study (BOREAS) is a multidisciplinary field and remote sensing study the goal of which is to obtain an improved understanding of the interactions between the boreal forest biome and the atmosphere in order to clarify their roles in global change. The two principal BOREAS field sites, both located within Canada, arc located in tbc southern boreal ecotone, encompassing Prince Albert National Park, Saskatchewan, and in the northern boreal ecotone near Thompson, Manitoba, This paper presents a very brief synopsis of measurements that were performed at the BOREAS experiment sites to examine the dielectric and hydraulic properties of several tree species within these sites.

EXPERIMENTAL DESIGN

We installed instrumentation designed to allow characterization of the hydraulic response of the vegetation in five stands within the BOREAS Northern and Southern Study Areas (NSA and SSA, respectively). The five selected stands were: (1) NSA Old Black Spruce (OBS), (2) SSA Old Black Spruce (OBS), (3) SSA Old Aspen (OA), (4) SSA Old Jack Pine (OJP) and (5) SSA Young Jack Pine (YJP). Within each stand, xylem water flux and bole temperature were monit ored in several trees. Microclimate and transpiration measurements were supplemented with mid-canopy air temperature and relative humidity observations to allow calculation of mid-canopy vapor pressure deficit. Also, soil temperature was monitored al various depths to obtain temperature profiles. These measurements were obtained continuously in most of the stands throughout most of 1994. Xylem water potential was also monitored at various times throughout the season.

instrumentation for continuously monitoring canopy dielectric properties was installed in four of the stands. An eight channel dielectric monitoring system (DMS) monitored L-band dielectric constant approximately 5- 10 mm deep within hydroactive xylem of the boles of eight trees in the SSA YJP stand from July through October 1994 (Zimmermann *et al.*, 1 995.), Single channel DMSs were installed in the SSA OJP (P-band), SSA OBS (P-band) and NSA OBS (C-band) stands. Each of these units monitored dielectric constant within the bole of a single tree from April through October 1994. Each DMS consists of an Applied Microwave Field Portable Dielectric Probe intc]-faced to a switching unit and a Delta-T Devices data logger (McDonald and Chun, 1995). Using a hand held PDP, dielectric profiles of three trees within each stand were obtained to establish a baseline to which the continuous dielectric measurements could be compared,

DISCUSS1ON

A very large amount of hydrologic and dielectric data was obtained during this study, The figures that follow present a small set of these. data as an illustration of the dielectric and hydraulic response of these stands. Figure 1 compares bole dielectric for seven days in April to seven days in June, 1994, for the NSA OBS, SSA OBS and SSA OJP stands. Also shown arc the xylem flux measurements from onc tree in each stand for seven days in June. The stand-to-stand variation in diurnal properties is evident. The change in diurnal dielectric response from April to June is also notable. Although trends in dielectric response can be seen, results from eight individuals in the SSA YJP stand demonstrate that pronounced within-stand variance in dielectric response. is present as well (Zimmerman ***et al.***, 1 995)

Figure 2 shows xylem flux, vapor pressure deficit, air and soil temperature and bole dielectric constant measured in the NSA OBS stand from April through October, 1994. This period spanned the entire growing season. Although the dielectric measurement series was begun after the trees began to thaw, a notable increase in the dielectric constant occurred between day 125 and 130. This corresponds to the period during which the upper 40 cm of the soil and moss layer thawed. Furthermore, as the growing season progresses, we observe not only a decrease in the amplitude of the diurnal dielectric response, but also a general decrease in bole dielectric constant until freeze-up occurs in late October.

These results indicate some very interesting trends observed in the diurnal and seasonal character of the bole dielectric constant which have implications on the radar backscatter derived from forests at different times during the day or season. It is clear that a careful analysis is needed to develop complete understanding of the observed dielectric phenomena.

REFERENCES

McDonald, K. C. and W. Chun, 1995. "Automated instrumentation for continuous monitoring of the dielectric properties of woody vegetation" (in preparation).

Zimmermann, R., K. McDonald, R. Oren and J. B. Way, 1995. "Xylem dielectric constant, water status, and transpiration of young jack pine (*Pinus Banksiana* Lamb.) in the southern boreal zone of Canada." *Proc. IGARSS '95.*

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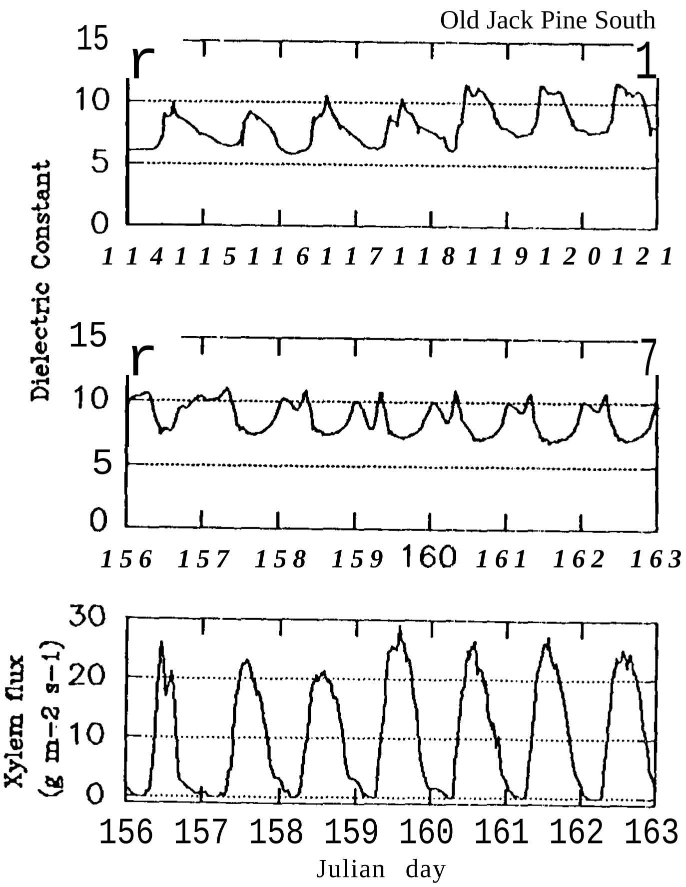

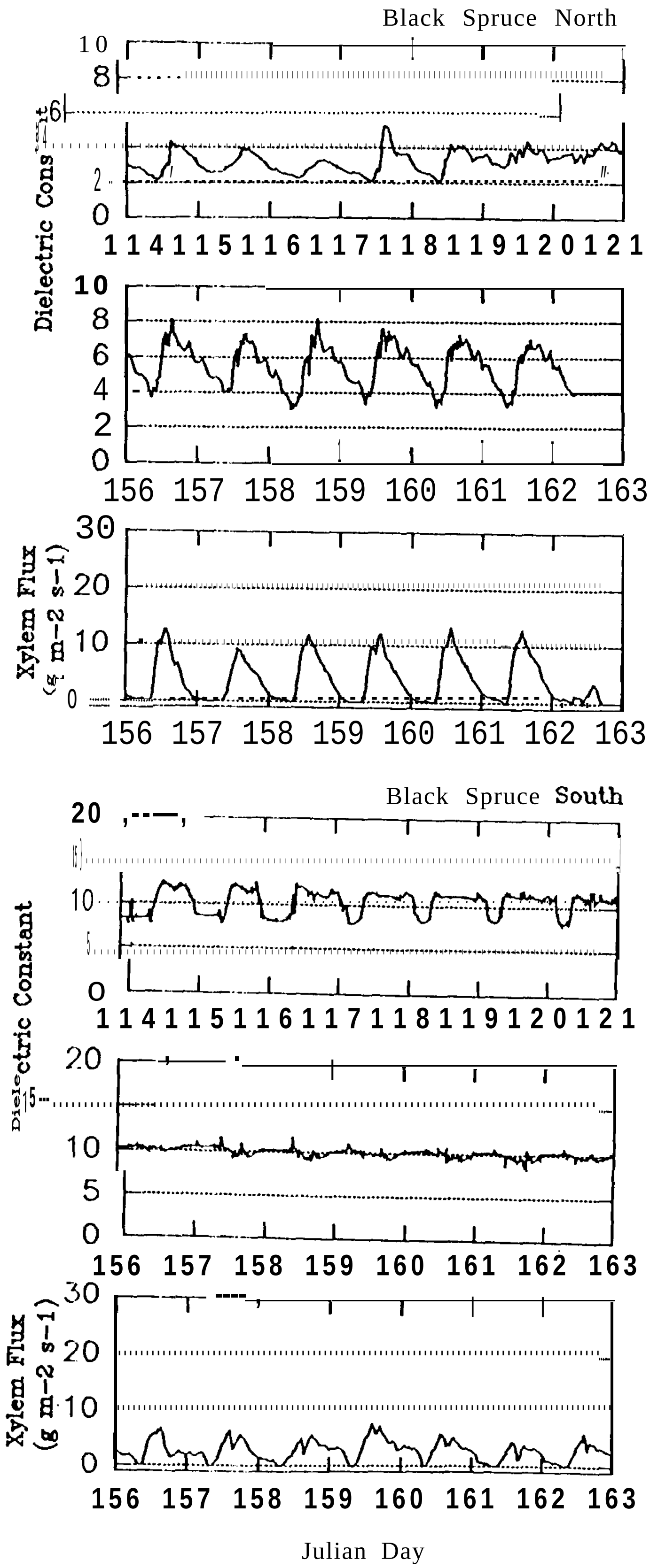

Figure 1: Bole dielectric constant and xylem water flux as observed in the SSA Old Jack Pine, NSA Old Black Spruce, and the SSA Old Black Spruce stands. Dielectric response is shown for one week in April and onc week in June.

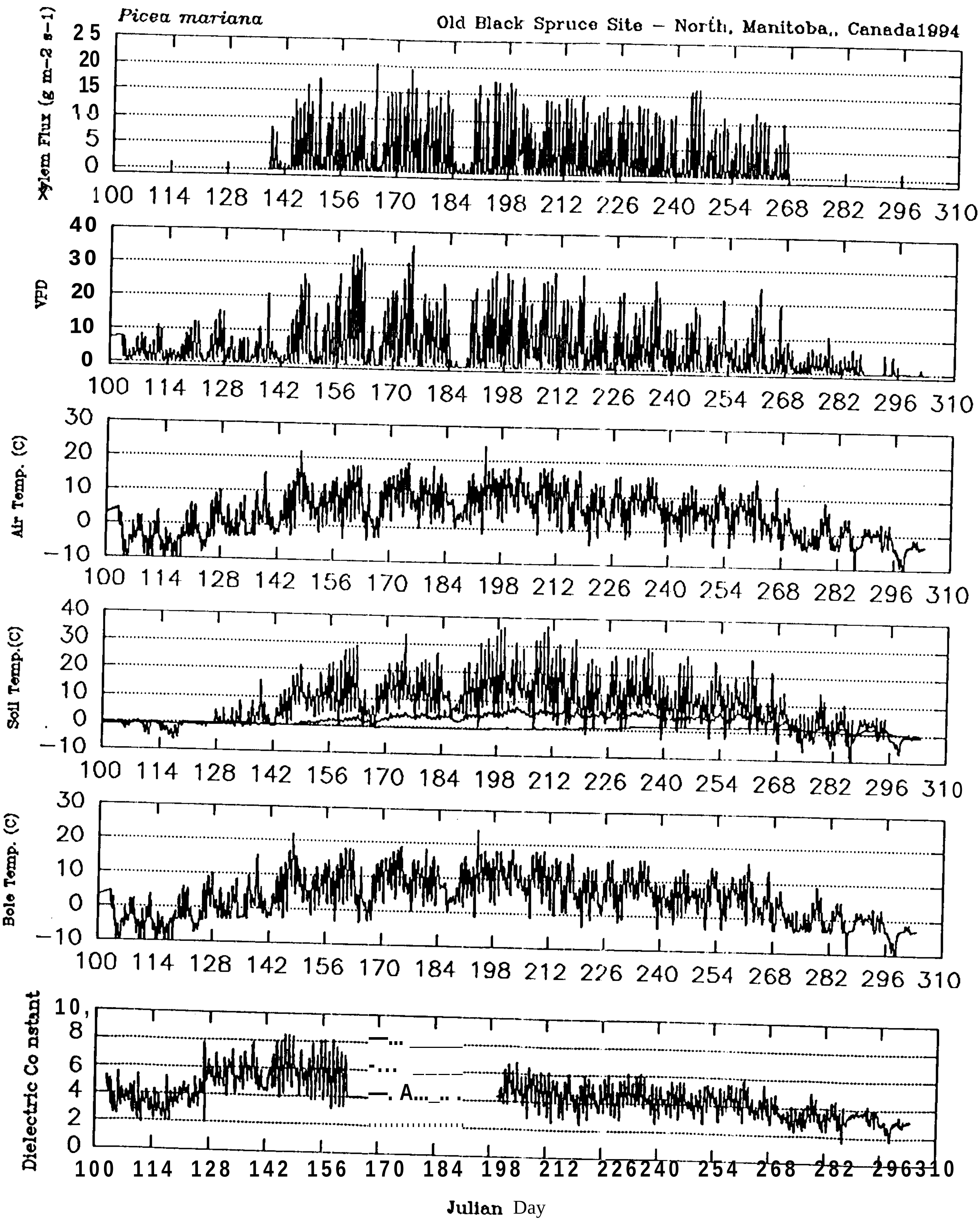

Figure 2: Xylem water flux, Vapor Pressure Deficit, air temperature, soil temperature profile, bole temperature and bole dielectric constant (C-band) as observed in the NSA Old Black Spruce stand.